1974

Across-Slope Farming Saves Rainfall Runoff

Cooperative Extension South Dakota State University

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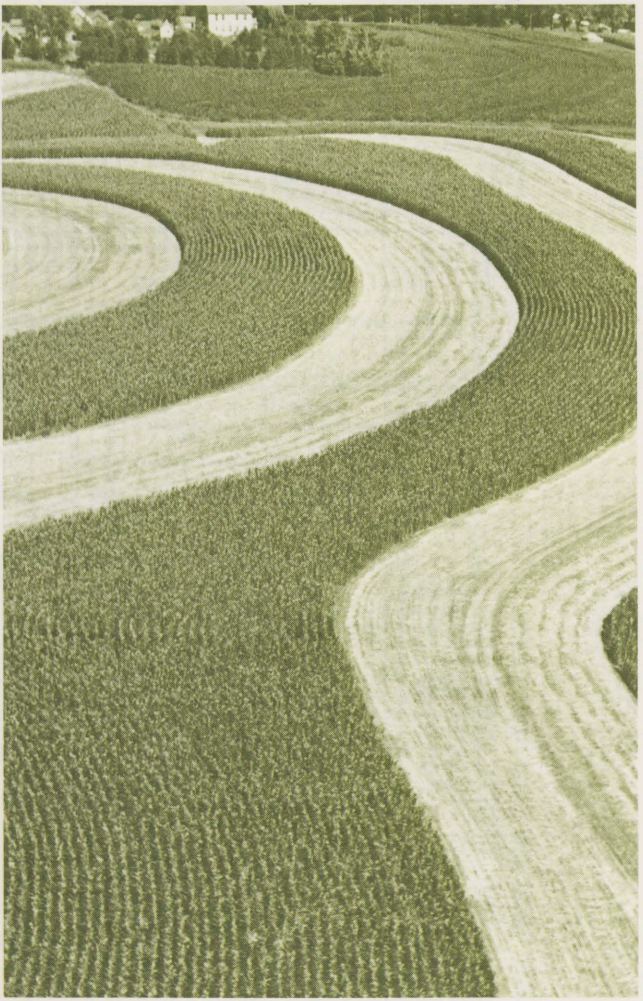


COOPERATIVE EXTENSION SERVICE
SOUTH DAKOTA STATE UNIVERSITY
U. S. DEPARTMENT OF AGRICULTURE

across-slope farming saves rainfall runoff

Ed Williamson and Quentin Kingsley
Extension agronomist—soils and
assistant professor, Plant Science Department

South Dakota's growing season rainfall usually is not sufficient for optimum crop production in all parts of the state in any one year. Limited rainfall some years could be more productive if runoff were saved. Serious water and soil loss by runoff on sloping land after intensive early summer storms occurs in some years. Lands with irregularly patterned slopes that are fall plowed or summer fallowed or with no surface residue protection in the early part of the growing season usually have the most damage. However, when effective conservation practices are applied, runoff can be significantly reduced.

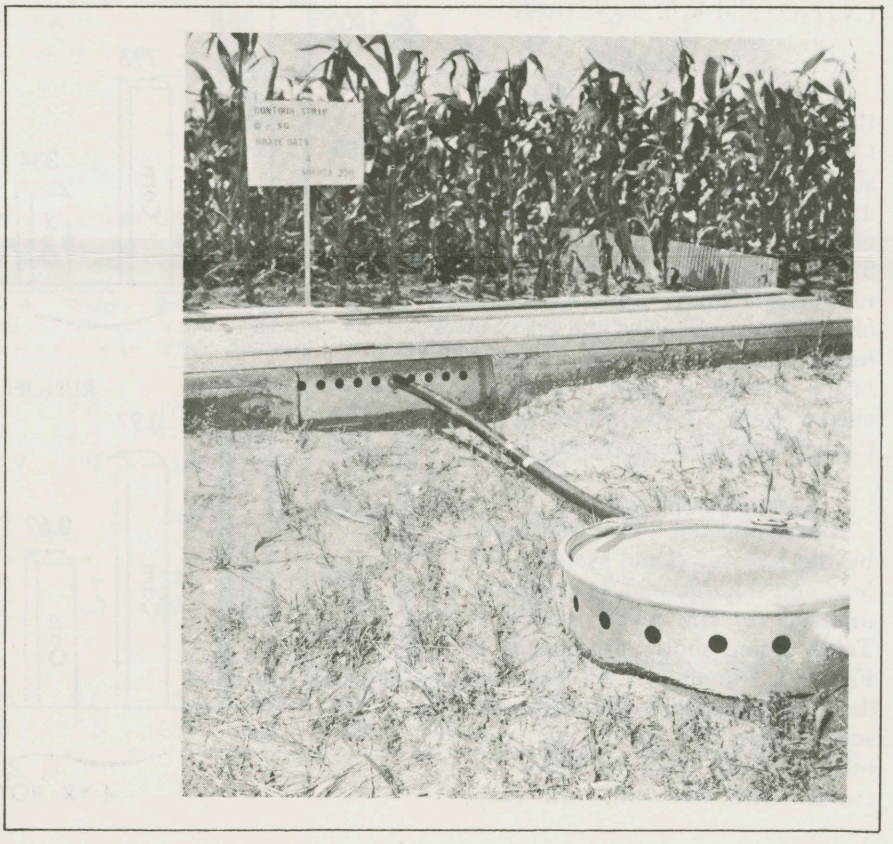
Demonstration Site and Procedure. It was with problems of this nature in mind that a runoff demonstration was started at the West Prairie Coteau Research Farm near Garden City, South Dakota. Nine plots were established in 1968 on Poinsett silty clay loam with a 4% slope. These and other silty soils are quite typical of almost 5 million acres of tillable land in eastern South Dakota, much of which have runoff and erosion problems.

Each of the 14 x 72 ft plots was enclosed on the sides and upper end with corrugated sheet metal, driven 4 inches into the soil and extending 4 inches above the surface. A sunken concrete collecting tank across the lower end of each plot received all runoff. If runoff exceeded the tank capacity, one-tenth of the excess was diverted to a 50 gallon submerged barrel, and similarly diverted to a second barrel when need occurred. The collecting system was calibrated to facilitate measurement of runoff volume. After each runoff, collected runoff was measured, sampled for soil-density determination, and the tanks were cleaned. The collecting system could accommodate a 9-inch runoff.

Two rotation systems were evaluated for the 5 year period of study —a 2-year corn-oats sequence and a 4-year sequence of corn-oats-alfalfa-alfalfa. Farming operations were performed up-and-down the slope for both rotational systems, and across-the-slope farming was also used with the 2-year sequence. A continuous fallow plot was maintained on one plot.

A mulch system of tillage was used for both rotational systems. Standard farm equipment was used for all tillage and harvesting operations. The mold-board plow implement was never used. Specific tillage operations for each crop were as follows:

1. **Corn.** (a) 2-year sequence: oat stubble minimum-tilled with 32-inch sweeps early fall; light spring disking prior to planting,



Acknowledgement: The authors wish to to express appreciation for assistance provided by the Conservation Districts of Area I in South Dakota. These eleven districts of the Northeastern area provided funds for construction materials for the demonstration.

using double disk opener type corn planter; maximum of two cultivations.

(b) 4-year sequence: Second year alfalfa killed by 2,4-D spraying after second cutting and minimum-tilled with 32-inch sweeps at the same time the oat stubble plots of the 2-year sequence were tilled, other operations same as the 2-year sequence.

2. **Oats.** Corn stalks chopped at 8-inch height and minimum tilled with 32-inch sweeps following corn harvest; tandem disked in spring prior to seeding with press drill equipped with double disk openers.
3. **Alfalfa.** Seeded with oats as companion in the 4-year sequence using legume attachment on press drill.
4. **Summer Fallow.** Tillage as needed for adequate weed control using field cultivator with 8-inch shovels.

Fertilizer was based on soil tests to meet nutrient needs for optimum yields and applied by spring broadcasting before seedbed preparation. The annual fertilizer treatments were: corn 60-30-0; oats 35-35-0; and alfalfa-oats 30-140-0, (N, P_2O_5 and K_20, respectively).

Precipitation

Monthly and total rainfall for the growing season (April through October) for the 5-year study is shown in Table 1. Long-time averages and the 5-year period are included for comparison. During the 5-year study total growing season rainfall was above the normal in 2 of the 5 years. During the years of below normal rainfall, storms heavy enough to cause runoff occurred early in the season when the soil was least protected.

Runoff and Soil Loss

Runoff and soil loss as influenced by the two rotational systems, fallow, and slope orientation are summarized for the 5-year period in Table 2, and shown graphically in Figure 1. Runoff and soil loss were the greatest under fallow where the soil surface had no residue protection. Next greatest losses occurred with the corn row crop, where the soil surface conditions were exposed to rainfall effects during the early part of the growing season before crop canopy protection, and next with the small grain of oats. Only negligible amounts of runoff and soil loss were evident with the first and second year alfalfa crop. Interestingly enough, these runoff and soil losses for both corn and oats were significantly reduced when the farming pattern was altered. Switching the direction of farming from up-and-down slope to across-the-slope, or contour farming, reduced runoff and soil loss for corn 29 and 51 percent, respectively. While the runoff and soil loss reductions were less pronounced for the oat crop, on a percentage basis 82 and 74 percent, they were even greater than for corn.

Crop Yields

Yearly and 5-year average yield and water use efficiency comparisons of the 2- and 4-year rotational systems for up-and-down slope farming and across-the-slope farming of the 2-year rotation are shown in Table 3. The yield differences between the 2 and 4 year rotations for up-and-down slope farming are quite comparable for each of the grain crops. Where noticeable variances occur, either the preceding year's carryover of fertility and/or soil moisture appear to be the influencing factors. The lower corn yields in 1971 for both rotation systems of up-and-down slope farming reflect the influence of the previous year's below normal rainfall, along with the depleting moisture effect alfalfa land has on subsequent cropping,

Figure 1. Five year average soil loss and runoff, West Prairie Coteau Research Farm, Garden City, South Dakota 1969-73

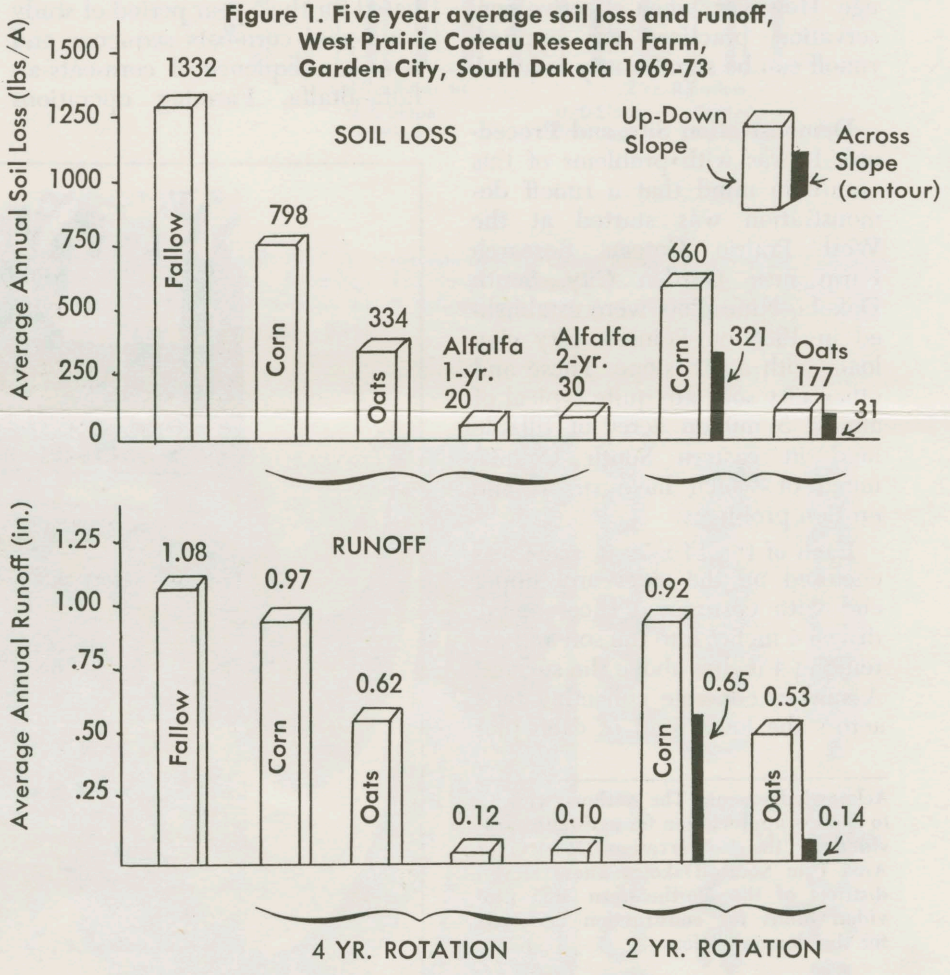


Table 1. Growing Season Rainfall Data: Long Term Average, 5 Year Average and Monthly Range, Garden City, South Dakota

	1969	1970	1971	1972	1973	5 Yr. Average	Long Time Average
				Inches			
April	1.13	2.03	1.83	3.33	1.42	1.95	2.19
May	3.44	2.65	2.69	6.99	1.24	3.40	2.85
June	2.47	4.70	4.95	1.16	1.24	2.90	4.00
July	6.51	1.52	1.01	5.08	1.41	3.11	2.87
August	0.76	0.22	5.81	1.56	1.60	1.99	2.96
September	0.56	1.66	1.41	0.32	1.91	1.17	2.27
October	2.27	1.75	4.23	1.63	0.82	2.14	1.52
Total	17.14	14.53	21.93	20.07	9.64	16.66	18.66
Departure Long Term Ave.	−1.52	−4.13	+3.27	+1.41	−9.02	−2.00	.....

Table 2. 5-Yr. Summary of Rainfall, Runoff and Soil Loss on Runoff Demonstration West Prairie Coteau Research Farm, Garden City, South Dakota

Year	Rainfall Inches	No. of storms		Up-and Down-Slope							Contour	
					4-Yr. Sequence				2 Yr. Sequence		2 Yr. Sequence	
				Fallow	Corn	Oats	Alfalfa	Alfalfa	Corn	Oats	Corn	Oats
			Runoff, Inches	.....	1.97	1.27	.27	.26	2.10	.98	1.03	.20
1969	17.14	6	Soil loss, lbs/A	.....	1506	1149	22	42	1924	558	412	91
			Runoff, Inches	1.81	1.67	1.60	.24	.05	1.79	1.51	1.51	.50
1970	14.53	2	Soil loss, lbs/A	1968	1388	176	60	00	1153	144	943	54
			Runoff, Inches	1.38	0.83	.04	.11	.18	.71	.09	.66	.02
1971	21.93	3	Soil loss, lbs/A	1786	616	116	20	145	222	24	348	10
			Runoff, Inches	0.92	.36	.19	00	00	00	.08	00	00
1972	20.07	2	Soil loss, lbs/A	1038	479	230	00	00	00	160	00	00
			Runoff, Inches	0.22	00	00	00	00	00	00	00	00
1973	9.64	2	Soil loss, lbs/A	534	00	00	00	00	00	00	00	00
5-Yr.			Runoff, Inches	4.33	4.83	3.10	.62	.49	4.60	2.66	3.25	.72
Total	83.16	15	Soil loss, lbs/A	5326	3989	1671	102	189	3299	886	1603	155
5-Yr.			Runoff, Inches	1.08	.97	.62	.12	.10	.92	.53	.65	.14
Ave.	16.66	3	Soil loss, lbs/A	1332	798	334	20	38	660	177	321	31

Table 3. Crop Yield and Water Use Efficiency of Runoff Demonstration West Prairie Coteau Research Farm, Garden City, South Dakota

Cropping Rotation	Crop	1969		1970		1971		1972		1973		5-Yr. Average	
		Bu/A or T/A	Water Use[1] Efficiency	Bu/A or T/A	Water Use Efficiency	Bu/A or T/A	Water Use Efficiency	Bu/A or T/A	Water Use Efficiency	Bu/A or T/A	Water Use Efficiency	Bu/A or T/A	Water Use Efficiency
						Up-and-Down Slope Farming							
4-Yr Sequence C-O-Alf-Alf.	Corn	70	4.7	87	7.0	49	3.7	93	6.2	26	2.7	65	4.9
	Oats	92	7.6	67	4.6	99	6.3	[2]	.....	35	4.0	73	5.6
	Alfalfa (1st yr)	1.7	.07	1.9	.07	3.8	.12	[3]	.....	1.6	.14	2.3	.10
	Alfalfa (2nd yr)	3.4	.13	4.9	.30	4.7	.20	5.3	.18	4.0	.24	4.5	.21
2-Yr. Sequence C-O	Corn	70	4.9	76	6.9	57	3.0	96	5.2	38	4.0	67	4.8
	Oats	80	7.3	72	5.0	79	5.2	70	5.6	38	3.8	68	5.3
						Across Slope Farming (Contour)							
2-Yr. Sequence C-O	Corn	81	5.1	98	9.0	72	4.2	110	8.1	44	4.0	81	6.1
	Oats	117	9.4	88	5.5	86	5.0	68	5.8	53	4.7	82	6.1

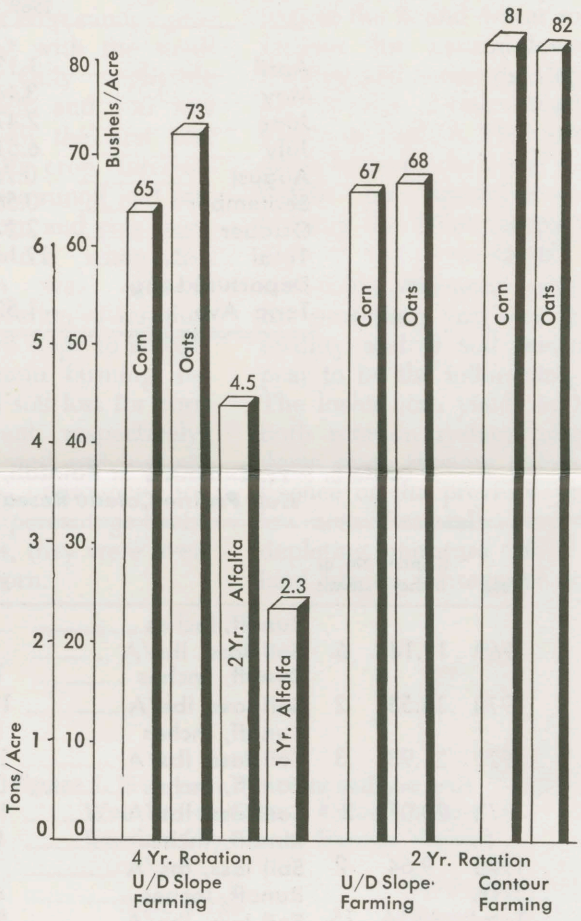
[1]Water Use Efficiency=Bu or Tons per inch of water used.
[2]Clipped to insure stand of new alfalfa seeding.
[3]First year alfalfa not harvested, thin stand.

particularily in years of below normal rainfall. The severest rainfall shortage of the study occurred in 1973 when a 9.02 inch deficit was recorded and is reflected by the lowest yields for the entire study.

It is interesting to note the effect across-the-slope or contour farming has on improving rainfall effectiveness. Corn yields were increased annually from 6 to 22 bushels per acre, with an average of 14 bushels more than yields received by up-and-down slope farming. Similarly, oat yields were increased by an average 14 bushels per acre. The 5-year average yields are graphically shown in Figure 2.

Water use efficiency is apparently greater under the contour farming system. Slightly more than 6 bushels of corn or oats were produced from each inch of water used under the contour system; while with the up-and-down slope farming 4.8 bushels of corn and 5.3 bushels of oats was produced with each inch of water used.

Figure 2. Five year average crop yields West Prairie Coteau Research Farm, 1969-73, Garden City, South Dakota



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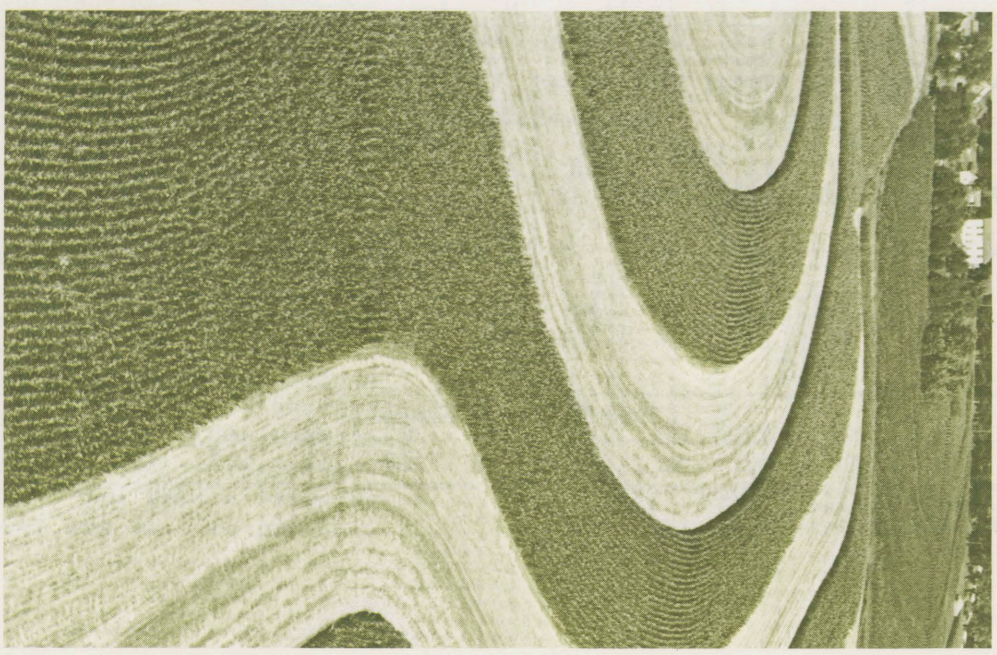

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